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A Review on different types of Condensers

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ABSTRACT

The following is a review paper for the different types of condensers which are used in industries. A condenser is essentially a device which is used to convert a substance from its gaseous state to its liquid state typically by cooling it. They are essential components in many industrial processes, HVAC systems, refrigeration cycles and power plants. This paper also talks about the different type of condensers presently used.

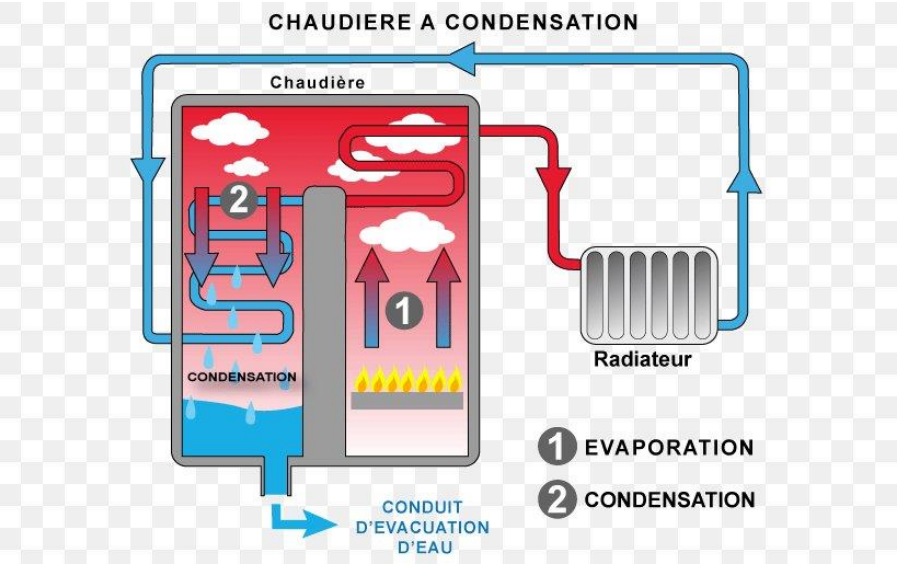
Keywords: Surface Condenser, Jet condenser

INTRODUCTION

Condenser

Condensing boilers are water heaters fueled by gas or oil. They achieve high efficiency (typically greater than 90% on the higher heating value) by condensing water vapour in the exhaust gases and so recovering its latent heat of vaporisation, which would otherwise have been wasted. This condensed vapour leaves the system in liquid form, via a drain. In many countries, the use of condensing boilers is compulsory or encouraged with financial incentives.

Block Diagram



Principle

In a conventional boiler, fuel is burned and the hot gases produced pass through a heat exchanger where much of their heat is transferred to water, thus raising the water's temperature.

One of the hot gases produced in the combustion process is water vapour (steam), which arises from burning the hydrogen content of the fuel. A condensing boiler extracts additional heat from the waste gases by condensing this water vapour to liquid water, thus recovering its latent heat of vaporization. A typical increase of efficiency can be

as much as 10-12%. While the effectiveness of the condensing process varies depending on the temperature of the water returning to the boiler, it is always at least as efficient as a non-condensing boiler.
The condensate produced is slightly acidic (3-5 pH), so suitable materials must be used in areas where liquid is present. Aluminium alloys and stainless steel are most commonly used at high temperatures. In low temperature areas, plastics are most cost effective (e.g., uPVC and polypropylene) [1]. The production of condensate also requires the installation of a heat exchanger condensate drainage system. In a typical installation, this is the only difference between a condensing and non-condensing boiler.
To economically manufacture a condensing boiler's heat exchanger (and for the appliance to be manageable at installation), the smallest practical size for its output is preferred. This approach has resulted in heat exchangers with high combustion side resistance, often requiring the use of a combustion fan to move the products through narrow passageways. This has also had the benefit of providing the energy for the flue system as the expelled combustion gases are usually below 100 °C (212 °F) and as such, have a density close to air, with little buoyancy. The combustion fan helps to pump exhaust gas to the outside.

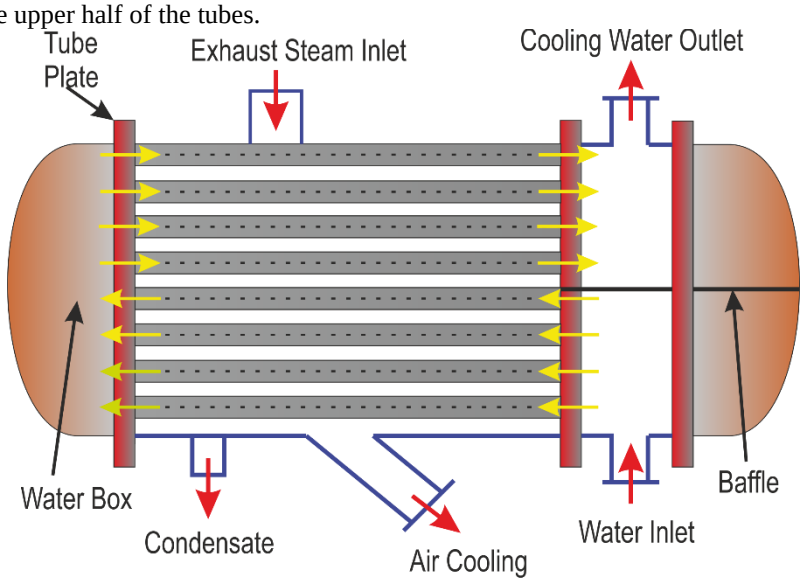
Types of condenser

1. **Surface condenser**
2. **Jet condenser**

Surface Condenser

Theory:

Working principle of **surface condenser** is completely different from jet condenser. In surface condenser exhaust steam and cooling water does not mix up with each other. So condensate remains pure and can be reused in the boiler. Surface condenser is widely used where limited quantity of water is available like ship, land installation etc. To use such a condenser, limited quantity of water feed to the boiler again and again.
In the diagram below, we can see the cylindrical shape ***surface condenser*** which is made off cast iron. In the condenser, some vessel packed with water tubes. Two vertical perforated tubes are placed two sides of the condenser and water tubes are fixed with these plates. In the tube, water flows from one direction to another direction. Cooling water flows in one direction to through the lower half of the tubes and returns in opposite direction through the upper half of the tubes.



Types Of Surface Condenser

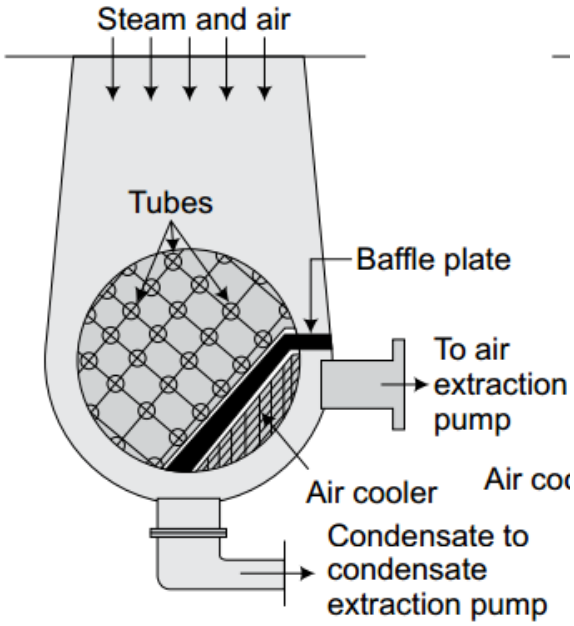
According to the direction of flow and arrangement of tubing system, **types of surface condenser** can be classified the following four categories.
1. Downflow surface condenser
2. Central flow surface condenser
3. Regenerative surface condenser
4. Evaporative surface condenser

Downflow surface condenser

Theory

In downflow surface condenser, exhaust steam enters the top of the condenser. Steam's direction is downside of the condenser due to gravitational force and an extraction suction pump fitted at the bottom of the condenser. The

condensate is collected at the bottom and then pumped by the extraction pump. A dry air pump suction pipe is also fitted at the bottom. It is covered by a baffte to prevent the entry of condensed steam into it.

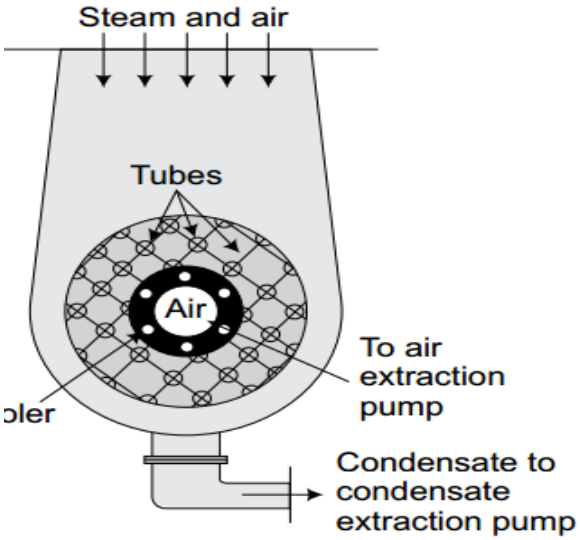


Down Flow

Central flow surface condenser

Theory:

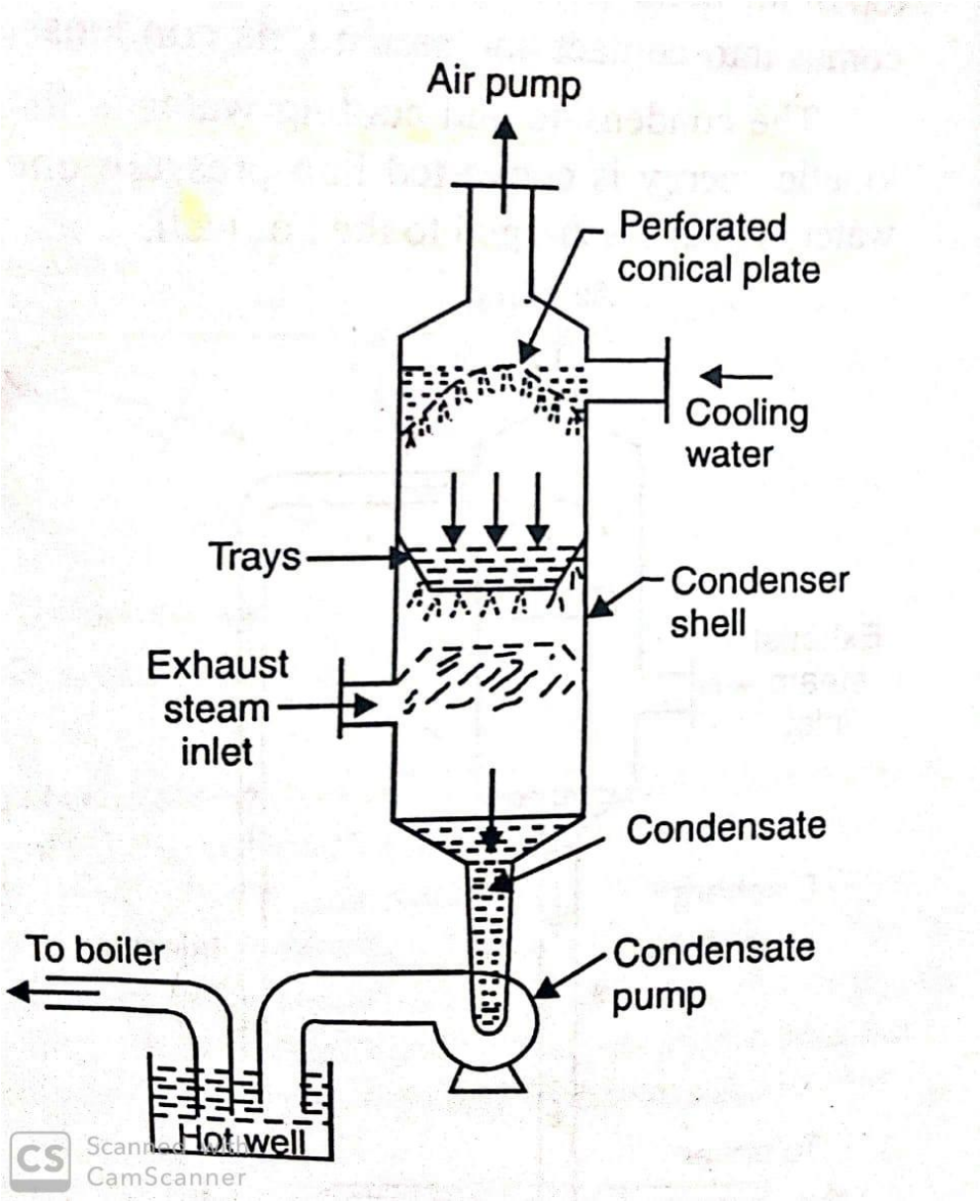
Central flow surface condenser is an improvement of downflow surface condenser. In this condenser, exhaust steam enters at the top of the condenser and flow downwards due to gravitational force. But suction pipe of the extraction pump is placed at the center of this condenser. So the steam flows radially inwards over the tubes towards the suction pipe. The condensate is collected at the bottom and pumped by the extraction pump.



Central Flow

Jet condenser

Jet condenser is a mixing type condenser where exhaust steam is condensed mix up with cooling water. In a jet condenser, high power is required for condensation. Design of jet condenser is simple. But after condensation, cooling water cannot be used to boiler as it is not free from salt and other impurities. So good quality water is used in ***jet condenser*** for condensation.



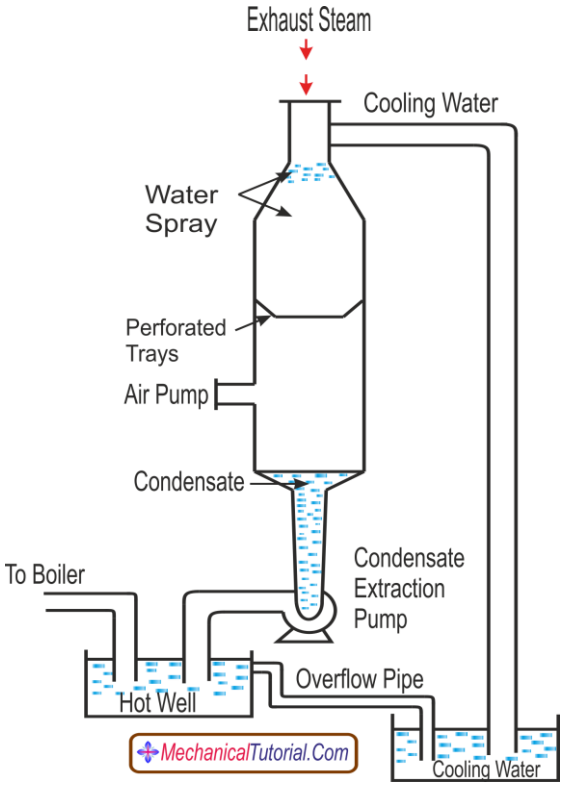
Types of Jet Condenser

1. Parallel flow jet condenser
2. Counter flow or low level jet condenser
3. Barometric or high level jet condenser
4. Ejector condenser

Parallel-Flow Jet Condenser

Theory:

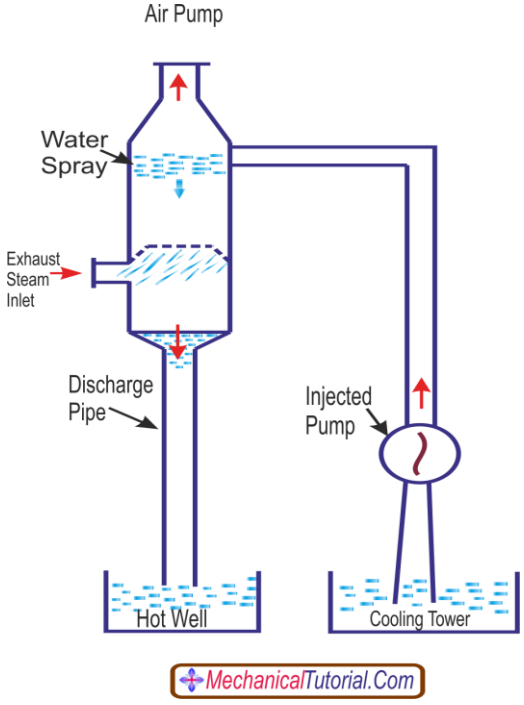
As you see in the diagram, exhaust steam, and cooling water enter the top of the parallel jet condenser and mix up together in the condenser shell. This mixture is removed from the bottom of the condenser. Actually, in the condenser, exhausted steam is condensed after mix up with water. The condensate cooling water and air flow's direction is downwards of the condenser and it is separated by two individual pumps which are air pump and condensate pump. A single way air pump is sometimes used for this separation. At the time of separation, a vacuum is created in the condenser chamber. Condensate extraction pump delivers the condensate to the hot well where an overflow pipe is connected to the cooling water tank where surplus water of hot well is stored.



Counter-Flow or Low Level Jet Condenser

Theory

In counterflow or low-level jet condenser, exhaust steam enters lower side and cooling water comes upper-side of the condenser chamber, see in the diagram. The direction of exhaust steam is upper-side and cooling water is downwards. Air pump has created a vacuum and it is placed at the top of the condenser shell. The vacuum draws the supply of the cooling water which falls a large number of jets. A perforated conical plate stores this falling water, from which it escapes in second series of jets and meets the exhaust steam entering at the bottom. Condensate and cooling water released for this rapid condensation to discharge the hot well through a vertical pipe by condensate pump.



CONCLUSIONS

In this experiment we have studied the various type of condensers and thus observed that the jet condensers are less suitable for high-capacity plants. It requires less quantity of cooling water as the condensing plant is simple. It also has low manufacturing cost and requires less floor space. Whereas the surface condenser is more suitable for high capacity plant and less power is required for air pumps but the manufacturing cost as well as the floor space required is high.

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